A PRELIMINARY WATER QUALITY EVALUATION OF THE WHITESAND RIVER (NORTHSHORE LAKE SUPERIOR)

1983

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Ministry of the Environment
Ontario

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DIRECTOR

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Summary

The Whitesand River is contaminated with heavy metals downstream of the abandoned zinc mine near Kenabic Lake to Hornblende Lake. Elevated concentrations of zinc and cadmium have had an adverse effect on the benthic community of the Whitesand River downstream of the mine site and Kenabic Lake. A near normal benthic community was present downstream of Hornblende Lake.

Introduction

In 1983, Corporation Falconbridge Copper continued exploration activities near the headwaters of the Whitesand River near the former Zenmac Metal Mines Limited property.

Staff of the Water Resources Assessment Unit conducted a preliminary water quality survey of the Whitesand River in June and September, 1983 to evaluate preoperational conditions and to determine whether impairment existed as a result of earlier mining activities. The study focused on water chemistry, sediment chemistry and some biological conditions in the Whitesand River and tributary waters.

Description of the Study Area

The study area is in the Whitesand watershed (130.5 km^2) which is located on the northshore of Lake Superior about 15 km west of Schreiber, Ontario (figure 1). The headwaters, about 30 km upstream of Lake Superior, are at an elevation of 518 metres. The river discharges to Lake Superior at an elevation of 183 m.

Near the headwaters, the river flows past the abandoned Zenmac Ltd. zinc mine. The Zenmac mine was in operation intermittently between 1898 and 1970. Additional flows discharge to the Whitesand River from Kenabic Lake via Kenabic Creek. The dilution potential of the Whitesand River is negligible until the

river reaches Longcane Lake. Further dilution is provided in Lyne Lake where the Ross Creek watershed enters. The river flows through Lyne Lake into Whitesand Lake and ultimately into Lake Superior.

Survey Methods

Field studies were conducted June 13 and 14, and September 28, 1983. Stations 1 through 10 were sampled during the June visits, and stations 9 through 11 were sampled on September 28. During the June visit, physical data were collected at each of ten stations. Dissolved oxygen (mg/ℓ), temperature (°C), pH and conductivity (μs/cm) were measured with portable field equipment. A secchi disc measurement was taken at Station 3 (Kenabic Lake) to estimate the extent of the euphotic zone.

Water samples were collected at surface for chemical and microbiological analyses except at station 3 on Kenabic Lake, where a composite sample was taken to a depth of 3 m. The water samples collected for heavy metal analyses were immediately preserved with 1 mℓ of concentrated nitric acid. Two sediment core samples were obtained by pushrod from both Kenabic Lake and Kenabic Creek. These core samples were extracted and subdivided into two cm sections and submitted for metal analyses.

On June 13 and 14, benthic macroinvertebrate samples were collected at five locations on the Whitesand River. The first location, on Kenabic Lake, was sampled with a ponar grab sampler (272 cm^2). Five samples were collected in the lake at various depths and locations. These samples were then screened through a 9.4 mesh/cm box screen. After washing, material retained in the screen was preserved in 95% ethanol for later identification.

Two surber samples (929 cm^2) from riffle areas and two additional qualitative samples were collected at each of the remaining four sites. The surber samples were taken in .15 to .25 m depth of water. The qualitative samples were collected from different habitats with a hand sieve. All samples were

sorted on the same day and identified at a later date in the laboratory.

Results & Discussion

Physical data are presented in Table 1. Saturated dissolved oxygen conditions were found at most sites except station 5, a location draining a low swampy area. This location was sampled because it drained a potential tailings site. The secchi disc depth in Kenabic Lake (Station 3) was 1.5 meters, and the water column was sampled to a depth of 2.5 m. It was not possible to obtain a clean sample below this depth because of the presence of a brown flocculant material.

Microbiological analyses of samples collected during June 13 and 14 are shown in Table 2. The levels found at all of the sites sampled indicated normal bacterial levels.

Water chemistry data are summarized in Tables 3, 4, 5 and 6. Elevated concentrations of hardness, conductivity, sulphate, calcium, magnesium and silicates were observed at Stations 3 and 4. There were slightly lower concentrations of the same parameters at Station 6, upstream of Cleaver Lake. Concentrations were further reduced with increased distance downstream from Kenabic Creek. Elevated silicate values were found in the lower portion of the watershed, Station 9 and 10. Ross Creek also exhibited greater concentrations of nitrate than that of the Whitesand River during this survey.

As shown, no significant difference was found in the chemistry analyses between Station 1, upstream of the abandoned mine, and Station 2, downstream of the mine. This suggests that Station 1 was not located far enough upstream or that background levels of zinc are elevated owing to local mineralization.

Extremely high concentrations of cadmium, cobalt, copper, nickel and zinc were found at Station 3, (Kenabic Lake) and Station 4, (Kenabic Creek). Both cadmium and zinc concentrations at Station 3 (5.5 and 1600 μg/ℓ) and Station 4 (6.1 and 2700

μg/ℓ) exceeded the Ministry of Environment guidelines for the protection of aquatic life. These guidelines are 0.2 μg/ℓ for cadmium and 30 μg/ℓ for zinc. Figures 2 and 3 show concentrations of cadmium and zinc at eleven stations on the Whitesand River. The Ministry objectives for the protection of aquatic life are also given.

Sediment core chemistry results are shown on Table 7 and Figure 5. Elevated concentrations of iron, aluminum, cadmium, arsenic, copper, mercury, cobalt and zinc were noted. Of greatest environmental concern is the extensive layering of zinc, copper, cadmium and arsenic in the upper horizons of Kenabic Lake and Creek. Due to the flocculant nature of the bottom sediments of Kenabic Lake, core samples from the deeper portion of the lake could not be obtained. Additional information should be collected from the remaining lakes in the Whitesand watershed in order to determine the levels of metals in downstream sediments.

Benthic macroinvertebrate collection results are given in Table 8. From the five ponar grab samples collected in Kenabic lake, only two mosquito larvae (Order Diptera) were found. As mentioned earlier, the substrate in deeper portions of the lake was blanketed by a layer of flocculant material. This condition has presumably created an environment which is inhospitable to aquatic organisms.

All stream sites were located in riffle areas containing sand and gravel with shoreline vegetation. These were some minor differences, however, in substrate character, gradient, stream velocity and aquatic vegetation. Figure 4 shows the relationship of total benthic taxa collected at four locations and the concentration of cadmium and zinc. The numbers of taxa increased as the values of cadmium and zinc decreased.

At Station 6, upstream of Cleaver Lake, fifty-two organisms were collected, representing fourteen taxa. At Station 7, downstream of Gumboot Lake, twenty-one taxa were represented, and of one hundred seventy-five organisms were collected. Twenty-eight taxa were identified from 1236 organisms collected at Station 8,

while at Station 10, 284 organisms, representing thirty-five taxa were collected. Reduced numbers and kinds of organisms were found at the upstream stations. Both the type of organism and density increased as one proceeded downstream.

Streamflow Data

Table 11 shows the prorated flow for the Whitesand River. This flow was calculated from data recorded at the Steel River, located some 50 kilometers to the east, and the Gravel River, located immediately to the west of the Whitesand River. The Whitesand River basin is divided into three sub-basins that are almost equal in size and consequently, discharge volume. Figure 6 shows the relationship of calculated flows in the Whitesand River to those of the recorded flows of the Gravel. Monthly and annual mean flows are shown for the watersheds. It appears that winter and late summer flows are extremely low in the upper portions of the Whitesand River, reducing dilution capacity and restricting available aquatic habitat.

Conclusions

The Whitesand River has been impacted by earlier mining activity as well as surface mineralization in the headwaters. Reduced numbers and diversity of macroinvertebrates appear directly related to elevated zinc and cadmium levels in the upstream reaches of the Whitesand River.

Prorated flows for the Whitesand River appear to be very low during winter and late summer periods. It is unlikely that there is sufficient flow to meet both natural and industrial needs in the headwater regions.

Sediments in the upper reaches contain very high levels of zinc, cadmium, cobalt, copper and nickel. Further studies are required, however, to delineate the the extent of metal contamination in the downstream sediments.

A comprehensive water quality and quantity management plan would be required to protect the Whitesand River if mining activities are resumed and effluents discharged to the upper Whitesand River.

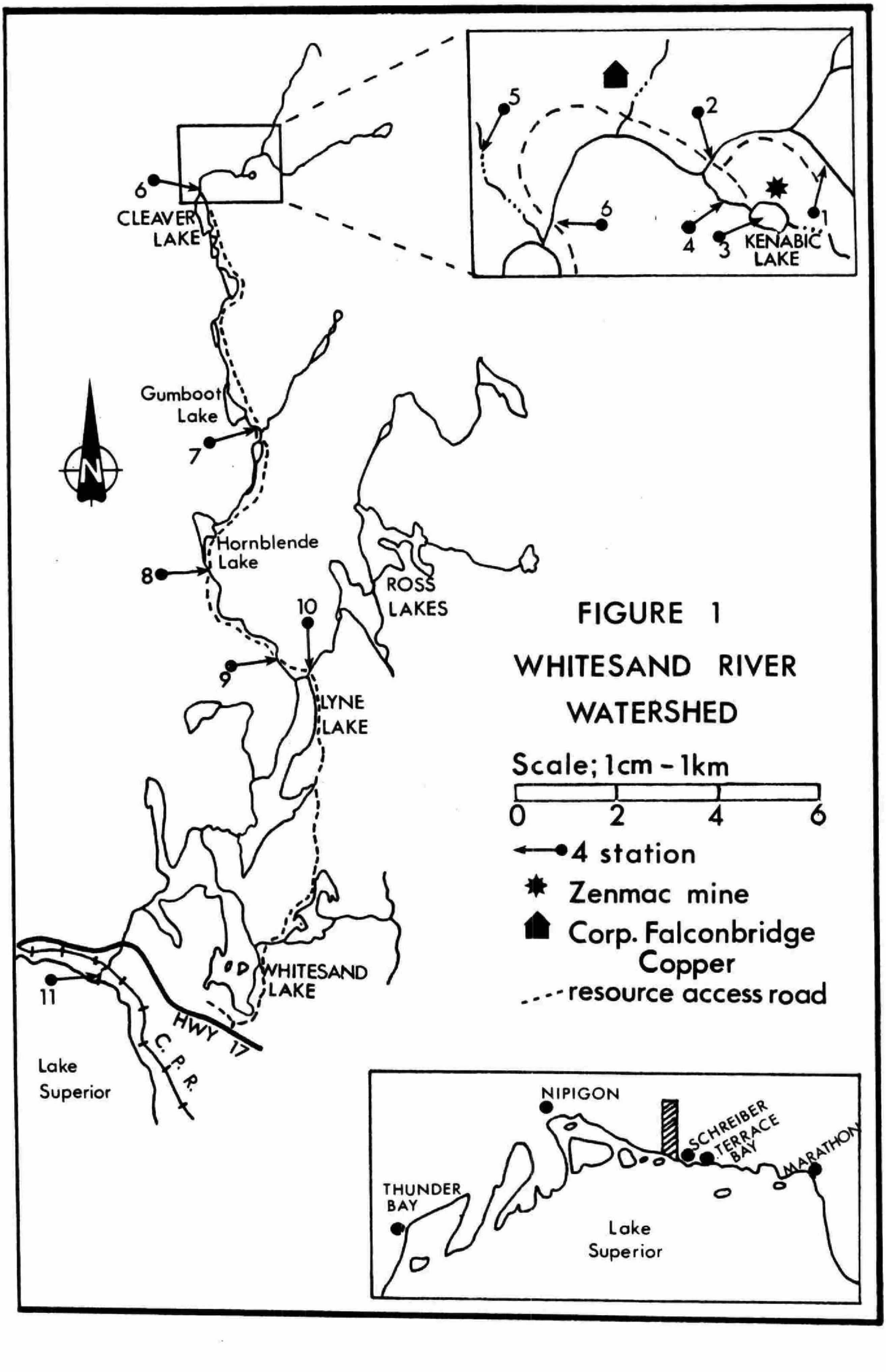


FIGURE 1
WHITESAND RIVER WATERSHED

FIGURE 2

ZINC VALUES,ug/L, AT TEN STATIONS
ON THE WHITESAND RIVER, 1983

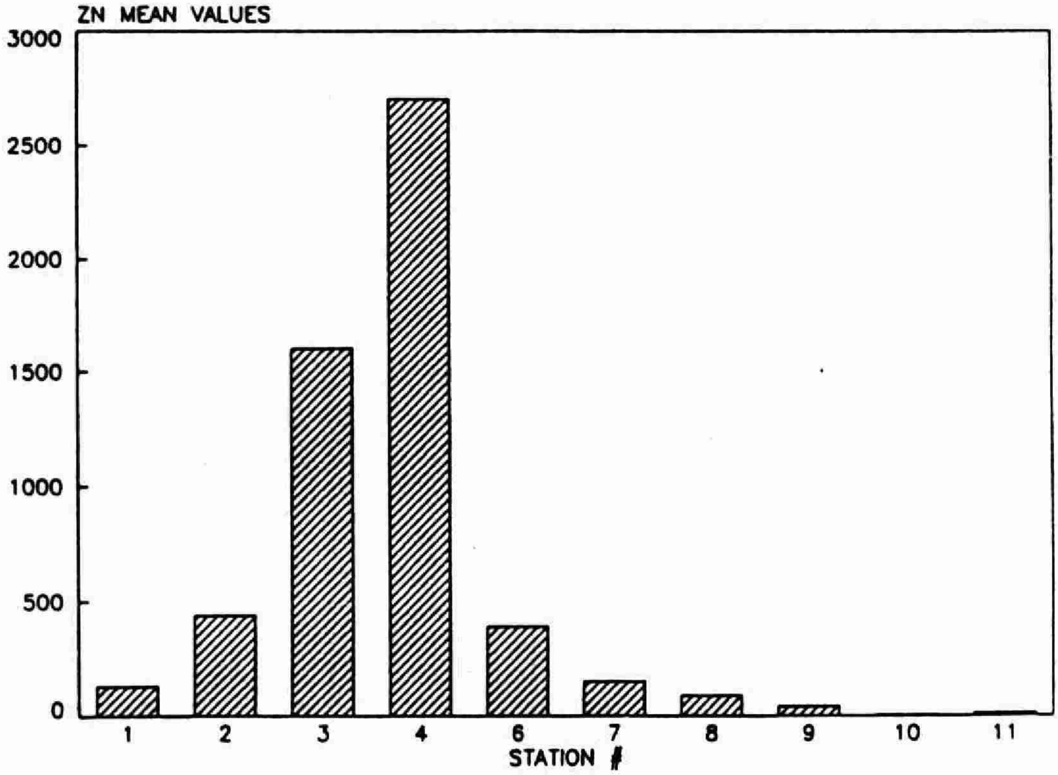


FIGURE 3

CADMIUM VALUES,ug/L, AT TEN STATIONS
ON THE WHITESAND RIVER, 1983

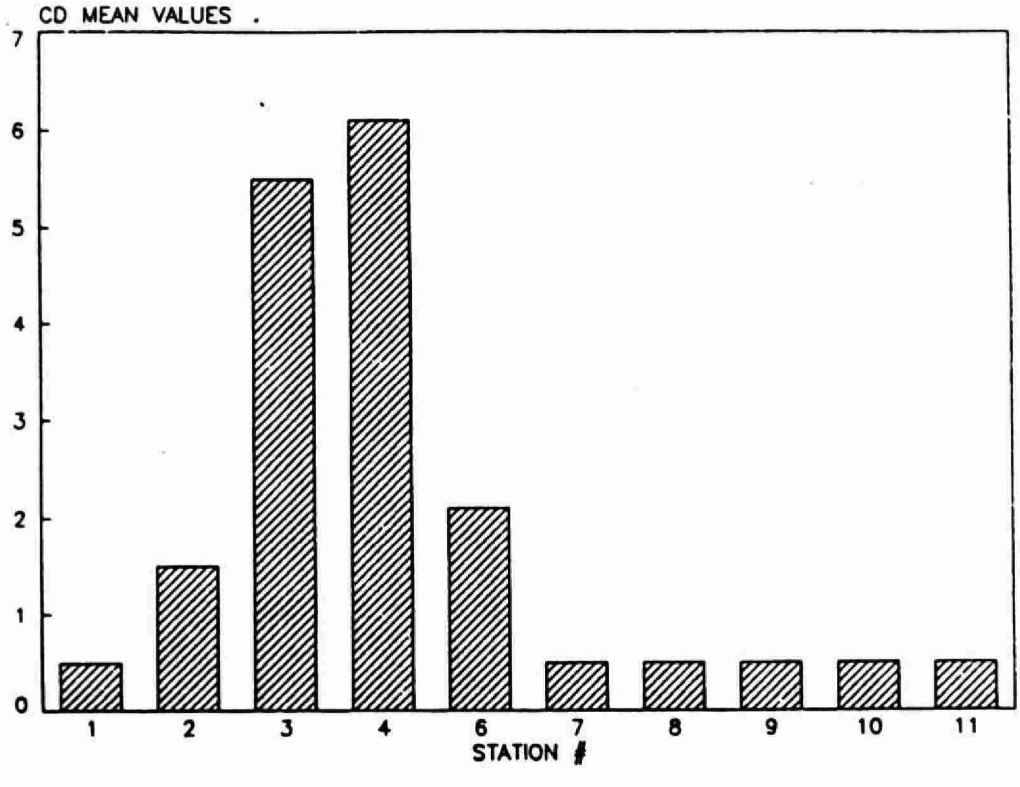


FIGURE 4. CONCENTRATIONS OF SELECTED METALS AND ORGANIC CARBON VERSUS DEPTH IN CORE SAMPLES COLLECTED FROM KENABIC LAKE.

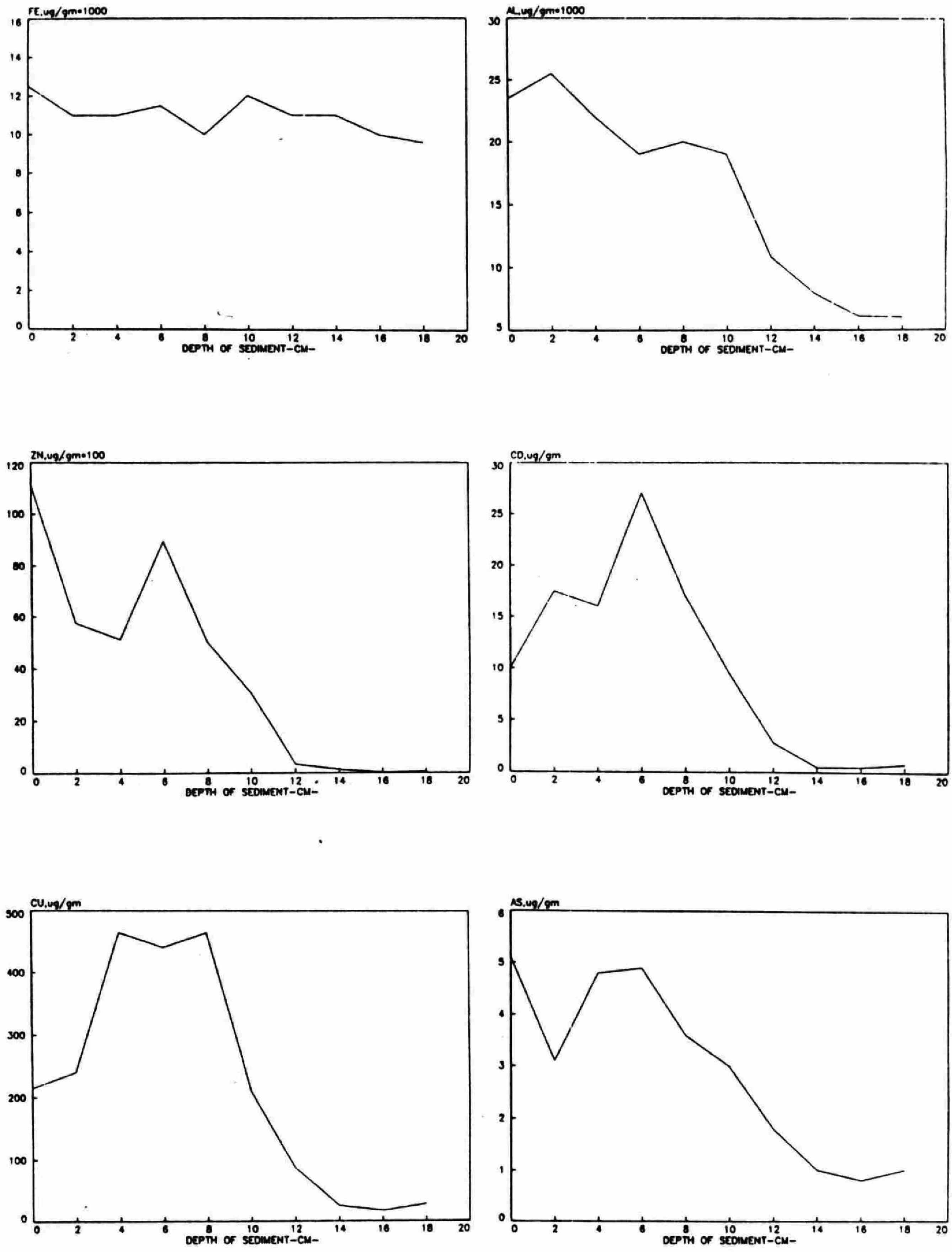
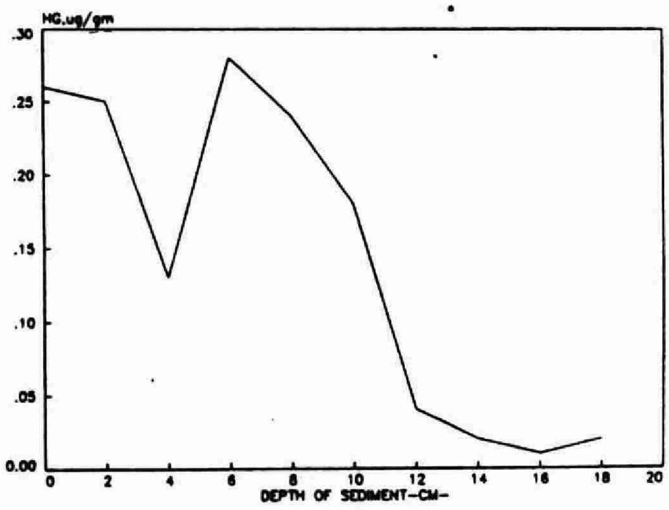
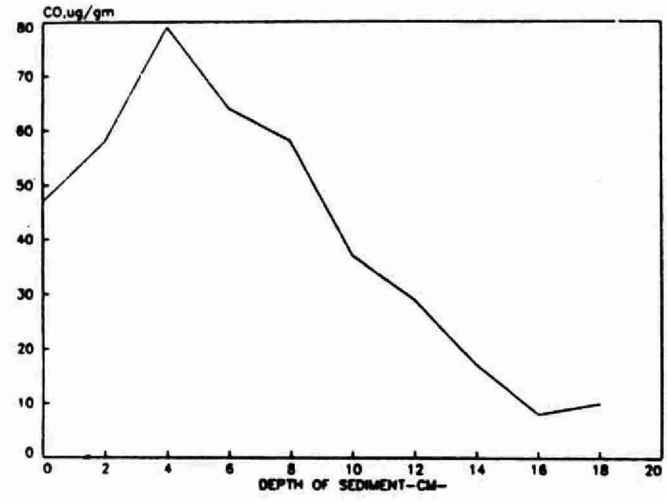


FIGURE 4. (Cont'd)





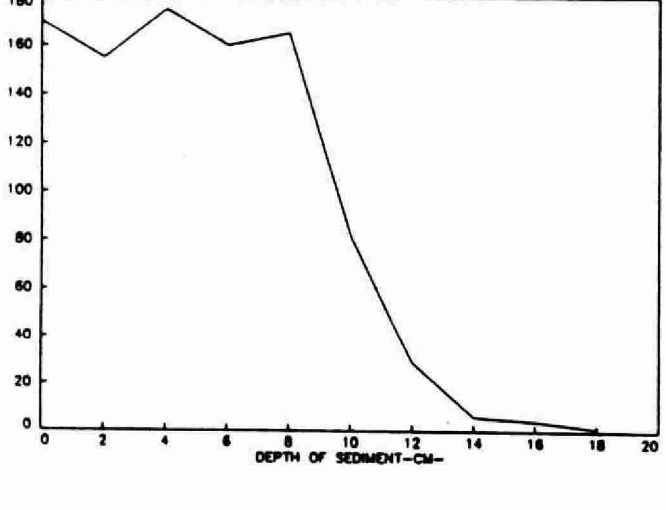


FIGURE 5

ZINC AND CADMIUM VALUES VS TOTAL NO. OF BENTHIC TAXA AT FIVE SITES, WHITESAND RIVER

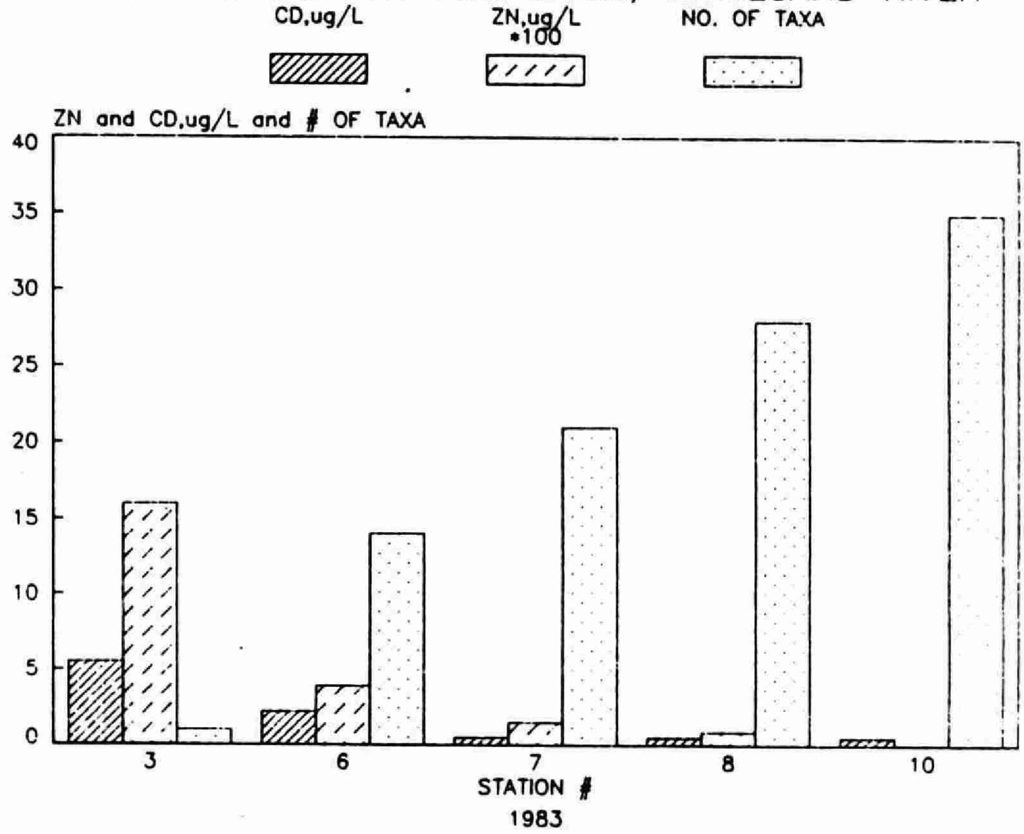


FIGURE 6

PRORATED MEAN MONTHLY FLOW DATA,CU.M./SEC FOR THE WHITESAND RIVER,1983

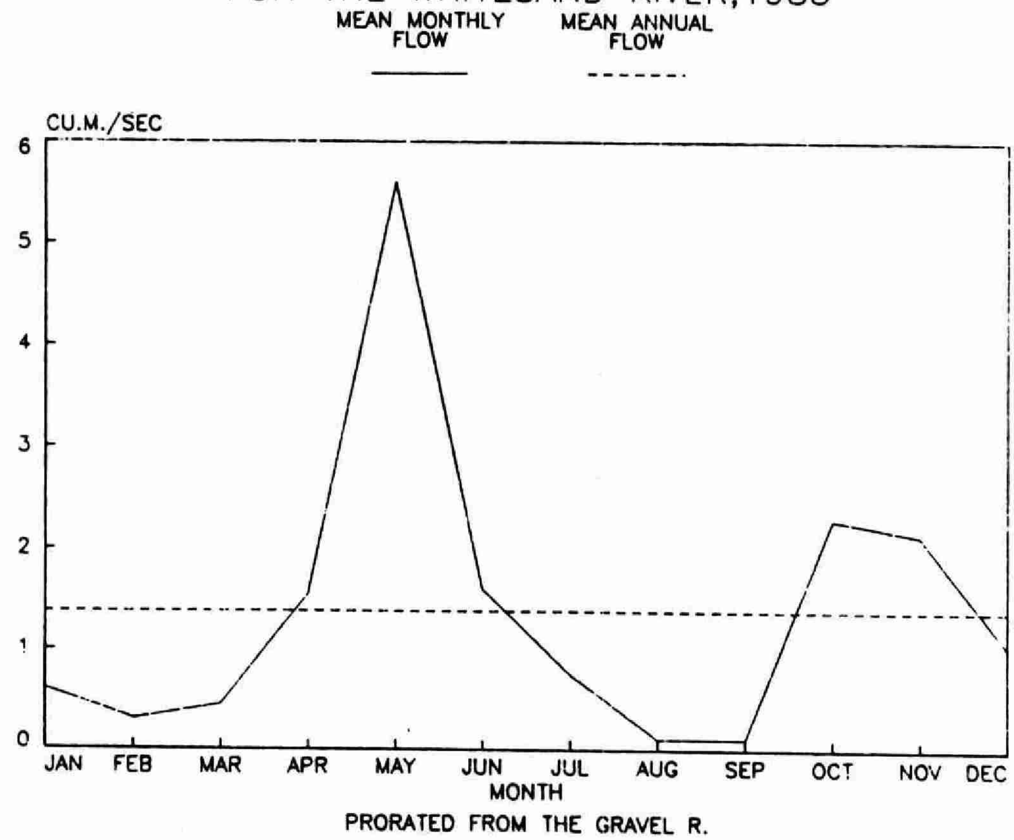


TABLE 1. Physical data collected on the Whitesand River, June 14 and September 28, 1983.

	Upstream Zenmac Mine 1	Downstream Zenmac Mine 2	Kenabic Lake 3	Kenabic Creek 4	Winston Lake Portage 5	Upstream Cleaver Lake 6	Downstream Gumboot Lake 7	Downstream Hornblende Lake 8	Upstream Lyne Lake 9	Ross Creek 10	Lakeshore Road 11
June 14, 1983											
Depth (m)	.2	.2	1.0/3.0	.2	.2	.2	.2	.2	.2	.2	-
Dissolved oxygen (mg/?)	7.9	7.5	10.5/8.5	8.5	4.9	7.7	6.6	9.6	7.7	8.7	-
Temperature (°C)	23.1	22.2	21.5/11.5	25.8	23.2	23.2	23.1	18.4	18.4	18.5	-
pH	7.05	6.9	6.85	7.1	5.95	7.4	6.85	6.85	7.05	6.9	-
Conductivity ("mhos/cm)	21	22	50	50	45	30	150	20	25	25	-
Secchi disc (m)	-	-	1.5	-	-	-	-	-	-	-	-
Composite depth (m)	-	-	2.5	-	-	-	-	-	-	-	-
Chlorophyll "a" (μg/ℓ)	-	-	1.6	-	-	-	-	-	-	-	-
September 28, 1983											
Depth (m)	-	-	-	-	-	-	-	-	.2	.2	.2
Dissolved Oxygen (mg/?)	-	-	-	-	-	-	-	-	8.8	9.8	9.8
Temperature (°C)	-	-	-	-	-	-	-	-	14.0	13.0	15.0

TABLE 2. Microbiological analysis conducted on water samples collected from the Whitesand River, June 14, 1983.

	Up-stream Zenmac Mine 1	Down-stream Zenmac Mine 2	Kenabic Lake 3	Kenabic Creek 4	Up-stream Cleaver Lake 7	Down-stream Gumboot Lake 8	Down-stream Hornblende Lake 9	Up-stream Lyne Lake 10	Ross Lake
Total coliforms	A800	2500	64	A600	A600	A400	112	124	1000
Fecal coliforms	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fecal streptococci	<4	44	<4	<4	20	<4	4	<4	<4
Background colonies	4100	6600	264	A400	4500	1100	364	1000	1800

A - approximately
< - less than
- all results expressed as counts (per 100 mℓ)

TABLE 3. Water chemistry at stations 1 to 10 on the Whitesand River, June 14, 1983.

	Upstream Zenmac Mine 1	Downstream Zenmac Mine 2	Kenabic Lake 3	Kenabic Creek 4	Winston Portage Trail 5	Upstream Cleaver Lake 6	Downstream Gumboot Lake 7	Downstream Hornblende Lake 8	Upstream Lyne Lake 9	Ross Creek 10
COD (mg/ℓ)	38	31	28	28	60	30	20	13	16	20
Free Ammonia (μg/ℓ)	20	10	<10	<10	20	<10	10	10	<10	<10
Total Kjeldahl N (μg/ℓ)	430	440	380	340	620	490	380	450	260	270
Nitrite (μg/ℓ)	5	4	3	3	11	5	3	3	3	3
Nitrate (μg/ℓ)	10	30	30	20	10	20	10	30	50	140
Total Phosphorus (μg/ℓ)	14	17	7	8	16	15	11	10	7	9
Dissolved Reactive Phosphorus (μg/ℓ)	2	1	2	1	2	3	2	2	2	2
Hardness (mg/ℓ)	10	10	17	18	7	12	10	7	8	17
Alkalinity (mg/ℓ)	8	7	6	6	3	8	7	3	7	6
pH	6.1	6.2	6.4	6.3	5.0	6.6	6.3	6.2	6.3	6.3
Acidity (mg/ℓ)	6	4	7	7	14	6	4	5	3	3
Colour (mg/ℓ)	103	101	57	52	236	104	78	64	53	50
Turbidity (mg/ℓ)	.45	.45	.55	.6	.35	2.7	.4	.35	.25	.7
Conductivity (μs/cm)	27	29	46	52	21	31	26	24	26	25
Chloride (mg/ℓ)	.2	.2	.1	.1	.2	.2	.2	.3	.2	.2
Sulphate (mg/ℓ)	6.4	7.3	14	16	7.6	7.4	5.8	5.6	5.5	5.3
Sodium (mg/ℓ)	.6	.44	.55	.62	.49	.57	.48	.59	.53	.53
Potassium (mg/ℓ)	<.04	<.04	<.04	.05	<.04	.19	.06	.16	.08	.10
Calcium (mg/ℓ)	3.5	3.7	4.4	4.5	2.3	4.2	2.9	2.7	2.9	2.9
Magnesium (mg/ℓ)	.64	.69	1.0	1.1	.64	.86	.69	.62	.66	.57
Silicates (mg/ℓ)	.4	.4	2.0	2.0	.5	.8	1.0	1.6	1.7	2.0

TABLE 4. Metallic water chemistry ($\mu g/\ell$) at stations 1 to 10 on the Whitesand River, June, 1983.

	Upstream Zenmac Mine 1	Downstream Zenmac Mine 2	Kenabic Lake 3	Kenabic Creek 4	Winston Portage Trail 5	Upstream Cleaver Lake 6	Downstream Gumboot Lake 7	Downstream Hornblende Lake 8	Upstream Lyne Lake 9	Ross Creek 10
Aluminum	250	240	280	340	450	490	220	210	170	160
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	.5	1.5	5.5	6.1	.6	2.1	<.5	<.5	.6	<.5
Chromium	2	2	<2	3	4	6	<2	<2	<2	<2
Cobalt	<2	<2	4	6	<2	<2	<2	<2	<2	<2
Copper	3	4	9	19	3	5	3	1	2	1
Iron	280	290	71	191	680	470	230	100	140	120
Lead	<3	<3	<3	<3	<3	3	<3	<3	<3	<3
Manganese	23	25	25	34	22	23	38	12	9	19
Mercury	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Nickel	2	3	10	16	<2	4	<2	<2	<2	<2
Zinc	130	440	1600	2700	7	390	150	88	64	2

TABLE 5. Water chemistry at stations 9 to 11 on the Whitesand River, September 28, 1983.

	Upstream Lyne Lake 9	Ross Creek 10	Lakeshore Road 11
BOD (mg/ℓ)	1.0	.8	.9
COD (mg/ℓ)	16	32	30
Free Ammonia (μg/ℓ)	<10	<10	<10
Total Kjeldahl N (μg/ℓ)	200	220	190
Nitrite (μg/ℓ)	2	2	1
Nitrate (μg/ℓ)	50	120	70
Total Phosphorus (μg/ℓ)	6	7	5
Dissolved Reactive Phosphorus (μg/ℓ)	1	1	1
Hardness (mg/ℓ)	16	13	19
Alkalinity (mg/ℓ)	10	6	11
pH	6.8	6.6	7.0
Acidity (mg/ℓ)	2	3	2
Colour (mg/ℓ)	23	32	19
Turbidity (mg/ℓ)	.20	.20	.20
Conductivity (μs/cm)	35	29	59
Chloride (mg/ℓ)	.3	.3	5.5
Sulphate (mg/ℓ)	4.9	5.0	5.0
Sodium (mg/ℓ)	1.7	1.7	3.5
Potassium (mg/ℓ)	<.04	<.04	.5
Calcium (mg/ℓ)	4.6	3.9	5.8
Magnesium (mg/ℓ)	.98	.69	1.2
Silicates (mg/ℓ)	1.6	1.6	1.8

TABLE 6. Metallic water chemistry (μg/ℓ) at stations 9 to 11, on the Whitesand River, September 26, 1983.

	Upstream Lyne Lake 9	Ross Creek 10	Lakeshore Road 11
Aluminum	40	50	40
Antimony	<1	<1	<1
Arsenic	<1.0	<1.0	<1.0
Barium	7	8	14
Cadmium	<.5	<.5	<.5
Chromium	5	<2	3
Cobalt	<2	<2	<2
Copper	2	2	3
Gold	<2	<2	<2
Iron	58	28	30
Lead	<3	<3	<3
Manganese	6	16	5
Mercury	<.05	<.05	<.05
Molybdenum	<1	<1	<1
Nickel	2	4	<2
Selenium	<1	<1	<1
Silver	<5	<5	<5
Strontium	13	11	16
Vanadium	<1	<1	<1
Zinc	20	3	12

TABLE 7. Metal concentrations (μg/g) in sediment core samples collected in Kenabic Lake and Creek, June 14, 1983.

Location	Depth (cm)	Fe (x1000)	Al (x1000)	Zn	Cd	Cu	Mn	As	Ba	Co	Cr	Hg	Mo	Ni	Pb	Sb	Se	Sr	Va	TOC
Kenabic Lake A	0-2	13	25	9,200	20	170	140	3.17	40.7	46	30	.26	4.0	79	11	.19	2.73	18	28.3	170
	2-4	13	30	6,000	18	200	120	2.67	49.6	66	34	.26	4.6	97	6.5	.19	3.02	18	37.9	180
	4-6	14	30	5,100	12	380	130	5.36	101.7	89	41	.24	7.5	150	6	-	5.75	22	68.3	190
	6-8	15	26	13,000	34	280	210	5.85	46.7	56	29	.30	3.0	86	17	-	3.44	16	35.5	160
	8-10	12	29	5,200	15	180	140	2.77	43.0	56	36	.21	<3	94	6.5	<.03	2.79	17	35.6	150
	10-12	11	29	4,600	14	180	130	2.97	41.1	56	34	.20	<3	96	3.5	-	2.67	16	34.2	160
	12-14	11	14	-	4.9	130	150	2.17	27.8	47	35	.07	<3	100	<3	<.03	1.21	17	34.6	48
	14-16	11	8.2	230	<.5	29	150	1.16	33.1	27	28	.02	<3	44	<3	<.03	.30	18	30.8	2.8
	16-18	8.9	5.8	22	<.5	16	110	.65	14.2	9.8	18	.01	<3	12	<3	<.03	.15	12	23.1	<.10
	18-20	9.6	6	56	.72	28	110	.96	13.8	10	19	.02	<3	13	<3	<.03	.30	11	24.8	1.2

TABLE 7. (Continued)

Location	Depth (cm)	Fe (x1000)	Al (x1000)	Zn	Cd	Cu	Mn	As	Ba	Co	Cr	Hg	Mo	Ni	Pb	Sb	Se	Sr	Va	TOC
Kenabic Lake B	0-2	12	21	13,000	<.5	260	330	7.12	41.2	48	23	-	<3	78	21	-	2.50	14	26.5	-
	2-4	8.9	21	5,500	17	280	160	3.47	69.8	49	29	.24	<3	79	6	<.03	2.44	14	27.4	130
	4-6	7.9	14	5,100	20	550	130	4.27	75.7	69	32	.03	<3	100	<3	.19	3.44	14	32.3	160
	6-8	7.9	12	4,900	20	600	120	3.97	68.9	71	31	.27	<3	100	<3	.31	3.44	13	29.2	160
	8-10	7.9	11	4,800	19	750	130	4.37	58.4	59	28	.26	<3	100	<3	<.03	3.93	15	27.8	180
	10-12	13	8.5	1,500	4.9	240	160	3.07	23.2	18	34	.08	<3	73	<3	<.03	1.82	22	37.7	4.4
	12-14	11	7.6	330	.67	43	150	1.36	21.4	10	28	.02	<3	42	3.5	<.03	.83	20	30.9	10
	14-16	11	7.5	38	.53	20	160	.75	19.7	6.9	29	.01	<3	18	<3	<.03	.20	22	31.8	8.9
	16-18	11	6.4	27	<.50	19	160	.96	18	6.2	24	.01	<3	13	<3	<.03	.10	20	30.6	8.3

TABLE 7. (Continued)

Location	Depth (cm)	Fe (x1000)	Al (x1000)	Zn	Cd	Cu	Mn	As	Ba	Co	Cr	Hg	Mo	Ni	Pb	Sb	Se	Sr	Va	TOC
Kenabic Creek A	0-2	13	18	7,800	29	450	280	6.64	30.6	33	28	.28	<3.0	93	33	<.03	4.18	14	20.3	280
	2-4	6.6	17	14,000	35	220	100	3.97	26	21	28	.19	<3.0	80	11	<.03	5.48	13	18	290
	4-6	6.1	18	13,000	23	240	110	4.37	26.2	22	25	.20	<3.0	78	15.5	<.03	4.18	13	19	280
Kenabic Creek B	0-2	7.9	26	16,000	81	630	91	5.06	31.3	25	32	.34	<3.0	110	54	.44	7.54	14	14.8	260
	2-4	4.5	21	21,000	24	180	66	2.77	31.1	22	28	.23	<3.0	76	10	.25	3.2	13	27.3	270
	4-6	3.7	19	25,000	9.9	150	73	4.27	33.6	28	25	.20	<3.0	71	6.5	.25	2.38	14	25.2	280
	6-8	7.8	19	13,000	34.0	330	150	6.64	35.1	53	30	.25	<3.0	91	26	.25	3.87	14	20.9	270

TABLE 8. Benthic macroinvertebrates collected at four locations on the Whitesand River, June 15, 1983.

	Kenabic	Upstream Cleaver		Downstream Gumboot		Downstream Hornblende		Ross Creek		Tolerance Position
	P	S	Q	S	Q	S	Q	S	Q	
<u>Ephemeroptera</u>										
Baetidae										
Baetis								3	6	F/I
Ametropodidae										
Ametropus									9	
Heptageniidae						29		41	1	
Heptagenia						7	1		7	I
Stenonema						4	4		5	I
Ephemerellidae										
Ephemerella		2	6					4	5	
Leptohlebiidae							1			
<u>Anisoptera</u>										
Cordulegastridae			1		1				1	F
Gomphidae					1	1	6		2	F/I
Lebellulidae					1	4			2	F
<u>Plecoptera</u>										
Perlidae				1		1	5		5	F/I
Perlodidae				7	4		5	1	2	I
Chloroperlidae			2	2	3	1	3		6	F/I
<u>Hemiptera</u>										
Gerridae										
<u>Gerris</u> <u>remigis</u>			3						1	T

TABLE 8. (Continued).

	Kenabic	Upstream Cleaver		Downstream Gumboot		Downstream Hornblende		Ross Creek		Tolerance Position
	P	S	Q	S	Q	S	Q	S	Q	
Trichoptera										
Philopotamidae										
Chimarra			2	12	32	30	20		7	I
Polycentropodidae										
Polycentropus				1		34			3	I/F
Phylocentropus									1	
Hydropsychidae		3								
Cheumatopsyche				1	20	560	53	20	44	F
Hydropsyche			4	33	18	230	21		19	I
Rhyacophilidae										
Rhyacophila				2	1		1		2	I
Glossosomatidae										
Glossosoma						27	8		14	
Brachycentridae										
Micrasema							4		1	I
Lepidastomatidae										
Lepidostoma			1			1		2		I
Limniphilidae						8		2	5	
Limniphilus					1	19	1		1	
Platycentropus							6		6	
Pycnopsyche							1			
Leptoceridae										
Ceraclea									2	F/I
Mystacides					2				3	
Unidentified Larvae									5	
Unidentified Adult		1								

TABLE 8. (Continued).

	Kenabic	Upstream Cleaver		Downstream Gumboot		Downstream Hornblende		Ross Creek		Tolerance Position
	P	S	Q	S	Q	S	Q	S	Q	
<u>Coleoptera</u>										
Gyrinidae			1							T
(Rhantus)		1								T/F
Dytiscidae										
Elmidae										
Elminae				1		5	3		1	F/I
Hydrophilidae			5							T
<u>Diptera</u>										
Culicidae	2				1					T/F
Simulidae										
Simulium					3	3		1	2	I
Chironomidae			6							
Chironominae				2	8	55	11	4	26	F/T/I
						4		1		
Unidentified Insecta										
<u>Acari</u> (mites)										
sp.				1						
<u>Hirudinea</u>										
Erpobdellidae										
<u>E. punctata</u>						1			1	T
<u>Annelidae</u>										
Oligochaeta										
Tubificidae				1						T/F

TABLE 8. (Continued).

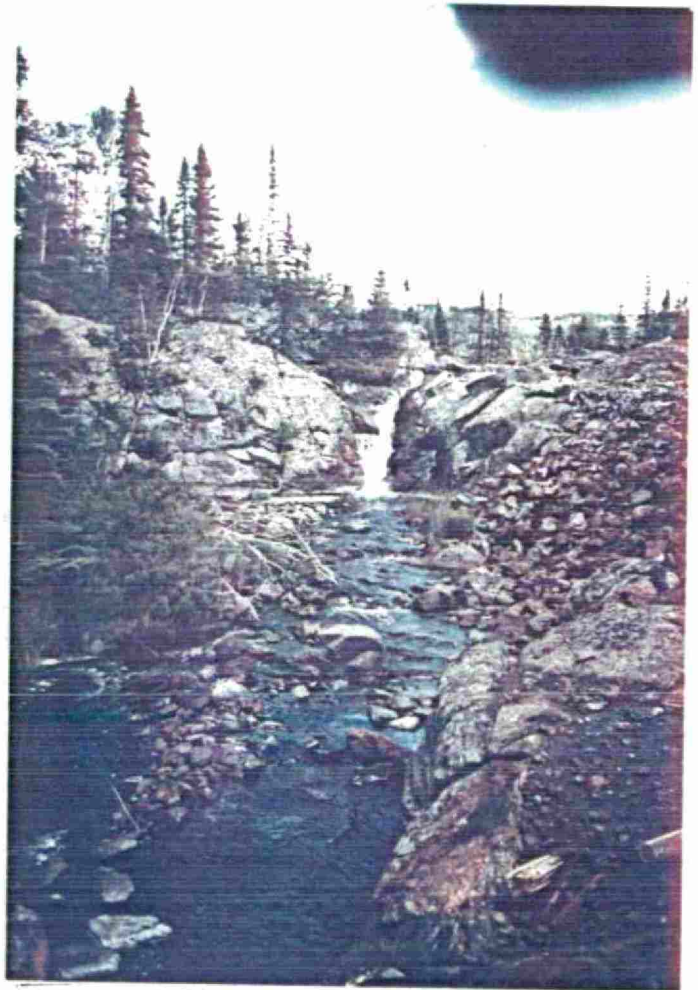
	Kenabic P	Upstream Cleaver S	Upstream Cleaver Q	Downstream Gumboot S	Downstream Gumboot Q	Downstream Hornblende S	Downstream Hornblende Q	Ross Creek S	Ross Creek Q	Tolerance Position
Tricladida (Turbellaria)										
Planaria										
Dugesia						1				F
Pelecypoda										
Sphaeriidae										
Sphaerium			14		6					F
S. lacustre					9		57		10	F
Total taxa	1	5	10	12	16	21	19	10	32	
Total taxa/station		14		21		28		35		
Total individuals	2	21	31	64	111	1025	211	79	205	

P = Ponar (5); S = Surber (2); Q = Quantitative (2)
Surber x 2 = 2 ft.^{2} = .2193 m^2
Ponar = 276 cm^2 x 5 = 1,380 cm^2
Tolerance Position - Tendency of organisms to disappear as degree of pollution increases.
I - Intolerant
F - Facultative
T - Tolerant

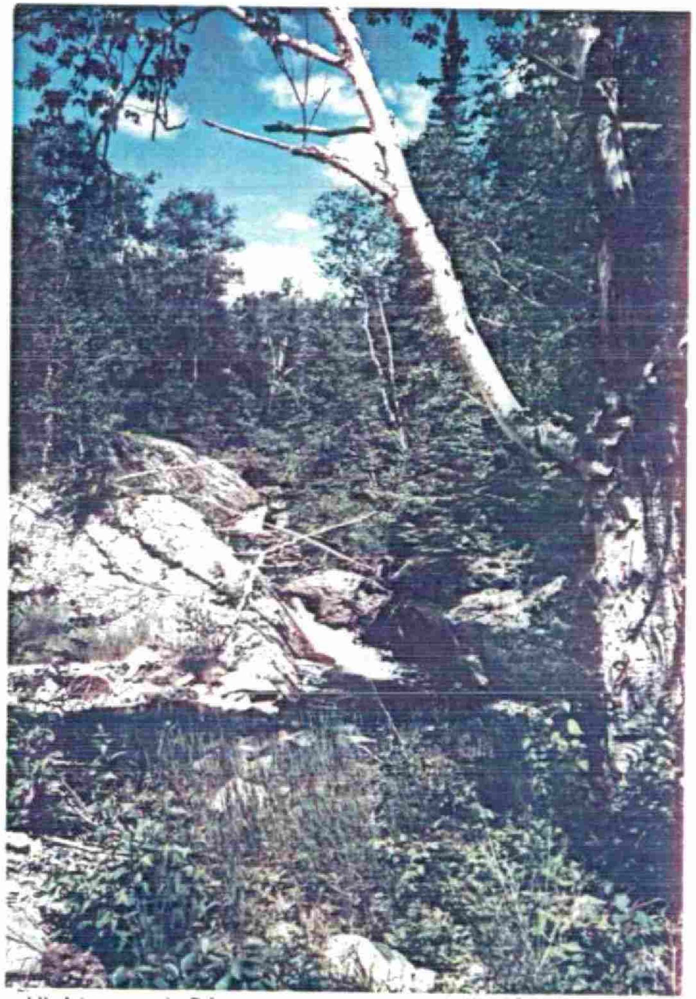
TABLE 9. Estimated Whitesand River watershed flow data (m^3/sec) prorated from recorded flows of the Gravel River, 1983.

Watershed Areas	Area ($Km/^2$)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Gravel River	616	2.86	1.43	2.11	7.25	26.3	7.47	3.51	.553	.527	10.7	9.95	4.81	6.48
Whitesand River	131.4	.610	.305	.451	1.551	5.611	1.590	.749	.114	.113	2.286	2.129	1.026	1.380
Lyne Lake and Whitesand River D/S	40.1	.186	.093	.138	.473	1.712	.485	.229	.035	.035	.698	.650	.313	.421
Ross Creek	43.2	.200	.100	.148	.510	1.845	.523	.246	.038	.038	.752	.700	.337	.454
Whitesand River U/S Lyne Lake	48.4	.225	.113	.166	.571	2.067	.586	.276	.042	.042	.842	.784	.378	.508
Whitesand River Hornblende Lake U/S	42.0	.195	.096	.144	.472	1.793	.508	.239	.036	.036	.731	.680	.328	.441
Whitesand River Gumboot Lake U/S	23.1	.107	.054	.079	.273	.986	.280	.132	.020	.020	.402	.374	.180	.243
Whitesand River U/S Cleaver Lake	12.1	.056	.028	.042	.143	.516	.146	.069	.010	.010	.210	.196	.095	.127
Whitesand River U/S Kenabic Lake	8.0	.037	.019	.027	.094	.342	.097	.046	.007	.007	.139	.130	.062	.084

U/S - upstream
D/S - downstream



Whitesand River, downstream of Zenmac
Mine, upper part of Zenith waterfalls,
waste rock in right foreground
June, 1984



Whitesand River, upstream of Cleaver Lake
at the Zenmac mine access road,
Station 6
June, 1984

Zenmac mine workings, Zenith ore zone beside Kenabic Lake
June, 1984

Corporation Falconbridge Copper's development headframe and surface buildings, Falcon Creek in foreground
June, 1984

Site of former Zenmac Metal Mines Ltd. mill and Selim siding on the C.P. Railway. Site partially rehabilitated
June, 1984

Tailings impoundment beside Selim siding on the C.P. Railway. No rehabilitation
June, 1984

	DATE DUE		